SLITTER DEVICE WITH ADJUSTABLE BLADE

FIELD OF THE INVENTION

The invention relates to a device for slitting sheet material, and more particularly to a device for cutting a sheet material for use in the manufacture of tobacco products such as cigarettes.

BACKGROUND OF THE INVENTION

Smoking articles, such as cigarettes, typically have a substantially cylindrical structure and include a charge, roll or column of smokable material such as shredded tobacco surrounded by a paper wrapper, thereby forming a tobacco rod.

The roll or column of tobacco used to fill the tobacco rod used in the manufacture of cigarettes may be cut from reconstituted tobacco sheet (such as, for example, R.J. Reynolds Tobacco Company so-called G-7 reconstituted tobacco sheet). Representative methods for making certain types of reconstituted tobacco sheet using papermaking-type processes are set forth, for example, in U.S. Pat. Nos. 3,847,164 to Mattina; 4,131,117 to Kite *et al.*; 4,182,349 to Selke; 4,308,877 to Mattina; 4,241,228 to Keritsis; 4,421,126 to Gellatly; 4,706,692 to Gellatly; 4,941,484 to Clapp *et al.*; 4,963,774 to Thomasson *et al.*; 4,987,906 to Young *et al.*; 5,056,537 to Brown *et al.*; 5,143,097 to Sohn *et al.*; 5,322,076 to Brinkley *et al.*; 5,325,887 to Young *et al.*; 5,377,698 to Litzinger; 5,445,169 to Brinkley *et al.*; 5,501,237 to Young *et al.*; and 5,533,530 to Young *et al.*; which are incorporated herein by reference.

In one representative process, the tobacco sheet, once formed from the tobacco pulp material, is then dried to about 12% moisture and has a temperature slightly greater than ambient before being directed to a downstream slitter device for slitting the sheet into ribbons of various widths such as, for example, on the order of about 1-3 inches wide. In some instances, the tobacco sheet, such as, for example, a G-7 reconstituted tobacco sheet, is about 85 inches wide (with standard thickness and basis weight of a reconstituted tobacco sheet) and is directed to travel at about 400 feet/minute to the slitter device.

Some slitter devices used in the production of tobacco products may have one or more rotating shafts with blades or knives attached thereto at intervals corresponding to the desired width of the ribbons that are to be cut from a sheet material. In multi-shaft slitters, first and second shafts are generally mounted in close proximity and have substantially parallel rotational axes. In these devices, the blades attached to the first shaft are configured to interact with corresponding blades attached to the second shaft. This configuration provides a precise shearing cut of the sheet material as it is directed through the slitter between the parallel rotating shafts. A two-shaft, complementary-blade arrangement has been described, for example, in U.S. Patent No. 4,449,540 to Marshal *et al.*, wherein a slitter-type machine is disclosed for cutting baled tobacco. According to the '540 patent, complementary circular blades on parallel shafts provide a shearing action to cut baled tobacco into sections of a specified width. In addition, U.S. Patent No. 4,566,470 to Brackman discloses the general use of closely-spaced counter-rotating discs to shred fibrous tobacco stem material to produce tobacco material suitable for use in cigarette production.

After repeated contact with the sheet material and the various components therein, such as plant stem material, and other hardened particles, including soil and mineral components, the blades may begin to wear. Wear may also result from the interaction of complementary blades on opposing shafts. Blade wear may occur in a non-uniform manner such that, in some instances, certain blades may exhibit more wear than other blades on the same shaft. This wear can result in deterioration of slitter performance since the now axially-separated complementary blades can no longer provide the necessary cutting action to cleanly cut the sheet material.

Some tobacco cutting machines disclosed in the prior art, such as in U.S. Patent No. 3,320,991 to Molins, provides a self-adjusting sharpening mechanism built into the machine for periodic re-sharpening of a collection of cutting blades attached to a single cutting drum. The Molins '991 patent does not, however, address blade wear on more than one shaft. Another single shaft tobacco cutting machine is disclosed in U.S. Patent No. 3,322,175 to Ward, wherein a clamp for providing a consistent clamping force on cutting knives affixed to a single rotating drum is described. The Ward '175 patent, however, describes the clamp (or "heel plate") as fitting within a fixed recessed portion

formed in the outer surface of the rotating drum such that the clamps are only applicable to a particular location on the drum.

In some previous dual-shaft slitter machines having closely spaced cutting blades aligned on a shaft, realignment of complementary slitter blades into an appropriate cutting relation often requires dismantling of all or part of the slitter machine. Such a process includes, for example, removal of the blades from one of the shafts, and the addition of spacers to that shaft, between the blades, in order to bring the individual blades on the shaft back into the appropriate cutting/shearing positions relative to complementary blades on the opposing shaft. Such a dismantling and realignment process may be disadvantageous due to the labor-intensive nature of the process and resulting machine down time. In some instances, less than optimal alignment of the blades upon reassembly may undesirably necessitate one or more iterations of the realignment process.

Thus, there exists a need for a slitter device capable of compensating for blade wear without the associated disadvantages of exemplary prior art slitter devices as discussed.

SUMMARY OF THE INVENTION

The above and other needs are met by the present invention, which, in one embodiment, provides a slitter device having substantially parallel first and second rotatable shafts. The first rotatable shaft is configured to extend axially through a first cutting blade. The second rotatable shaft is configured to extend axially through a second cutting blade. The slitter device provides for the second cutting blade to be selectively secured along the length of the second rotatable shaft as to allow the second cutting blade to be aligned in a cutting relation relative to the first cutting blade. Accordingly, as one or both of the cutting blades experience wear, the second cutting blade may be readily readjusted along the second rotatable shaft to maintain the cutting relation.

In one embodiment of the present invention, each axially-adjustable cutting blade is provided with a collar mechanism for securing the respective blade to the shaft. In other embodiments, a plurality of first and second cutting blades may be provided with the respective first and second rotatable shafts, typically in equal numbers such that each

first cutting blade corresponds with a second cutting blade to form a set of complementary cutting blades, with at least one of the cutting blades being axially adjustable. In such instances, the axially adjustable cutting blade in each set of complementary cutting blades is independently and individually movable with respect to others of the axially adjustable cutting blades on that shaft. That is, a single one of the axially adjustable cutting blades on a rotatable shaft may be axially adjusted, independently of the remainder of the axially adjustable cutting blades on that shaft and without imparting an effect thereto or having an interaction therewith.

Thus, embodiments of the present invention provide significant advantages as further detailed herein.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

Having thus described the invention in general terms, reference will now be made to the accompanying drawings which are not necessarily drawn to scale:

Fig. 1 shows a perspective view of a slitter device according to one embodiment of the present invention;

Fig. 2 shows a cross-sectional view of a slitter device according to one embodiment of the present invention;

Fig. 3 shows a cross-sectional view of a slitter device depicting blade wear and resulting misalignment of the blades that can be remedied by embodiments of the present invention; and

Fig. 4 shows cross-sectional view of a slitter device according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present inventions now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. This invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to

like elements throughout.

Fig. 1 shows one embodiment of a slitter device **1** according to the present invention, comprising a first rotatable shaft **10** extending axially through a first cutting blade **12.** The first cutting blade **12** may be fixed with respect to the first rotatable shaft **10.** The first cutting blade **12** is axially separated from adjacent cutting blades on the first rotatable slitter shaft **10** by, for example, spacers **14.** A second rotatable shaft **20** is positioned substantially parallel to the first rotatable shaft **10.** The second rotatable shaft **20** extends axially through a second cutting blade **22.** Though the slitter device **1** is described herein in terms of single first and second cutting blades **12,22,** one skilled in the art will appreciate that a plurality of such blades may be provided on each of the respective first and second rotatable shafts **10,20,** wherein such a configuration is shown in the accompanying figures. In one embodiment, for example, the rotatable shafts **10,20** have a length of about 110 inches and extend through 24 sets of complementary cutting blades **34.** In such an embodiment, the profiles of the first and second cutting blades **12,22** are substantially circular and have an overall diameter of, for example, about 10.5 inches, while the first and second rotatable shafts **10,20** are also substantially circular and have an outer diameter of, for example, about 6 inches.

In one embodiment, the second cutting blade **22** is secured via a collar **24,** to the second rotatable shaft **20.** The collar **24** may be secured to the second rotatable shaft **20** by a securing member **26** such as, for example, a set screw extending radially through the collar **24,** to provide a fixed engagement between the collar **24** and the second rotatable shaft **20.** Once the collar **24** is secured to the second rotatable shaft **20,** the associated second cutting blade **22** becomes axially fixed relative to the second rotatable shaft **20.** However, the securing member **26** may be selectively disengaged from the second rotatable shaft **20** so that the collar **24** and associated second cutting blade **22** can be axially moved relative to the second rotatable shaft **20.**

As shown in **Fig. 2,** the second cutting blade **22** is positioned with respect to the first cutting blade **12** so as to define a cutting position wherein the first and second cutting blades **12, 22** form a set of complementary cutting blades **34** that cooperate to cut the sheet material. In the cutting position, the first and second cutting blades **12,22** are axially positioned along the respective rotatable shafts **10,20** to be immediately adjacent

to each other, and to extend radially from the respective first and second rotatable shafts **10, 20** so as to radially overlap in the space **30** defined between the shafts **10,20**. In one embodiment, the first and second cutting blades **12,22** may be separated, for example, by an axial space of about 0.003 to 0.005 inches, with a radial overlap between the first and second cutting blades **12,22** of about 0.25-0.50 inches and, in some instances, about 0.375 inches.

Each cutting blade **12, 22** may be formed of, for example, hardened and tempered cold-finished steel alloy, such as AISI E52100, or any other material suitable for cutting the sheet material. Further, the collar **24** may be formed of, for example, stainless steel tubing, such as Type 316, S31600 stainless steel, while the securing member **26** (including those embodiments where the securing member **26** includes first and second sleeves **26a, 26b**) may be formed of specialized stainless steel alloy, such as for instance, Nitronic 60, UNS S21800, or other suitable material. One skilled in the art, however, will appreciate that such material selection for each particular component is provided herein for example only, and is not intended to be limiting in any respect for the respective component.

In operation, the sheet material is fed toward the space **30** defined between the shafts **10,20**, in perpendicular relation to the axes of the shafts **10,20**. Accordingly, the shafts **10,20** may be configured to counter-rotate, as shown in **Fig. 1**, such that the blades **12,22** angularly converge toward the sheet material being fed toward the space **30** defined between the shafts **10,20**. The sheet material may comprise, for example, reconstituted tobacco sheet (such as, for instance, an R.J. Reynolds Tobacco Company so-called G-7 reconstituted tobacco sheet), paper stock, laminate material, or other sheet material. The counter-rotation of the sets of complementary cutting blades **34** cuts the sheet material into ribbons having widths substantially equal to the axial distance between adjacent sets of complementary cutting blades **34**.

The rotatable shafts **10,20** may be driven, for example, by appropriate motors and gearing mechanisms, or other drive mechanisms capable of, for instance, adjusting the relative speeds of the rotatable shafts **10,20**. One skilled in the art will appreciate that many different types of motors and/or gearing or drive mechanisms, or combinations thereof may be used, as appropriate or desired, to drive the rotatable shafts **10,20** in the

manner described herein, wherein such types of motors and/or gearing or drive mechanisms are independent of the functionality of the slitter device **1** according to various embodiments of the present invention. According to one embodiment, the sheet material is forwarded to the slitter device **1** at about 400 feet per minute, and the shafts **10,20** are configured to counter-rotate at an angular speed of within about ±5% of the linear feed rate of the sheet material. In one advantageous embodiment, the shafts **10,20** are configured to counter-rotate at an angular speed of about 2% greater than the linear feed rate of the sheet material. In addition, the slitter device **1** may be fitted with a conveyor belt or other feed mechanism (not shown) for conveying the sheet material toward the cutting blades **12,22**. One skilled in the art will appreciate, however, that other conveyor devices such as, for example, roller drums, may be implemented to feed the sheet material, wherein such conveyor devices may, in some instances, be assisted by vacuum mechanisms or the like for ensuring efficient feeding of the sheet material.

As shown in **Fig. 3**, after a period of operation one or both of the cutting blades **12,22** in a set **34** may be sufficiently worn such that the cutting position, or the axial space of about 0.003 to 0.005 inches between the cutting blades **12,22**, is no longer maintained. Wear of the blades may be cause by, for example, contact with the respective complementary cutting blade, interaction of the cutting blades **12,22** with irregular components that make up the sheet material, or interaction of the cutting blades **12,22** with the sheet material itself. As a result of blade wear, an axial gap **40** (greater than about 0.005 inches) is formed between the opposing radially overlapping surfaces of complementary cutting blades **12, 22** such that the cutting blades **12,22** are no longer in the cutting position, thereby adversely affecting the cutting performance of the slitter device **1**.

As shown in **Fig. 3**, according to one advantageous aspect of the present invention, the second cutting blade **22**, is axially movable relative to the second rotatable shaft **20** so as to allow the second cutting blade **22** to be adjusted to restore the cutting position relative to the first cutting blade **12**, as shown in **Fig. 2**. Such an adjustment of the second cutting blade **22**, may be accomplished by, for example, sufficiently disengaging the securing member **26** from the fixed engagement with the shaft **20** and axially adjusting the collar **24** and/or the second cutting blade **22** with respect to the first

cutting blade **12** so as to restore the cutting position.

One skilled in the art will appreciate that the axial adjustment of the second cutting blade may be achieved using various types of collars and securing members. For example, the collar **24** may comprise a non-contiguous ring having opposing portions defining an angular gap. The securing member may further be configured to operably engage the portions of the ring, across the gap, wherein the securing member is capable of reducing the gap so as to provide a compression fit or other manner of a friction-type fit between the collar **24** and the second rotatable shaft **20**.

According to another advantageous aspect of the present invention, as shown in **Fig. 4**, the second rotatable shaft **20** extends through a collar **24** having a threaded radially-outward surface, wherein the radially-outward surface in configured to, in turn, extend axially through the second cutting blade **22**. Each collar **24** extends axially over a length of about 6 inches. In such an embodiment, the securing member **26** comprises a first sleeve **26a** having a pin **27** engaged therewith and extending axially therefrom, and a second sleeve **26b** configured to cooperate with the first sleeve **26a** so as to axially and rotationally fix the second cutting blade **22** with respect to the collar **24.** The collar **24** is rotationally fixed with respect to the second rotatable shaft **22** by an axially-extending key **21** extending between the collar **24** and the second rotatable shaft **20**. In some embodiments the collar **24** may also be axially fixed with respect to the second rotatable shaft **20** by abutting an adjacent collar **24**, wherein a series of abutting collars **24** may be axially secured with respect to the second rotatable shaft **20**, for example, by end nuts at opposing ends of the second rotatable shaft **20**.

As shown in **Fig. 4**, the second cutting blade **22** is axially secured between the first and second sleeves **26a,26b**. More particularly, each of the first and second sleeves **26a,26b** may include a threaded radially-inward surface corresponding to and configured to be capable of threadedly engaging the threaded radially-outward surface of the collar **24**. In some embodiments, the sleeves **26a,26b** may comprise, for example, threaded nuts, each having a radially-outward surface defining spanner wrench flats for facilitating axial adjustment thereof with respect to the collar **24** by a spanner wrench. In such a configuration, the first sleeve **26a** is threaded onto the collar **24** to a desired axial position with respect thereto. The second cutting blade **22** is then installed about the collar **24** and

into axial engagement with the first sleeve **26a** such that the pin **27** extending axially from the first sleeve **26a** engages a corresponding axially-extending aperture **29** defined by the second cutting blade **22**. The second sleeve **26b** is then threaded onto the collar **24**, opposite the second cutting blade **22** from the first sleeve **26a**, such that the second cutting blade **22** is secured therebetween.

In order to axially adjust the second cutting blade **22** with respect to the collar **24**, and thus the second rotatable shaft **20**, the second sleeve **26b** first rotated so as to be moved axially away from the second cutting blade **22**. The first sleeve **26a**, having the second cutting blade **22** engaged therewith via the pin **27** / aperture **29** interaction, is then rotated so as to axially move the second cutting blade **22** to the desired axial position on the collar **24**. Once the second cutting blade **22** is adjusted to the desired axial position with respect to the complementary first cutting blade **12** with the first sleeve **26a**, the second sleeve **26b** is axially moved back into engagement with the second cutting blade **22**. The first and second sleeves **26a,26b** are then concurrently counter-rotated so as to be directed in opposite axial direction, toward the second cutting blade **22**. One skilled in the art will appreciate that the counter-rotation of the first and second sleeves **26a,26b** serves to compress the second cutting blade **22** therebetween and the resulting compressive interaction between the collar threads and the sleeve threads axially and rotationally secures the second cutting blade **22** and the first and second sleeves **26a,26b** with respect to the collar **24**. Accordingly, in this manner, the second cutting blade **22** is axially and rotationally secured between the first and second sleeves **26a,26b.**

Further embodiments of the slitter device **1** may provide for axial blade adjustment on more than one shaft so as to provide additional adjustment capabilities for the slitter device **1**. Such a configuration may be advantageous in instances where, for example, the desired width of the ribbons of the sheet material cut by the slitter device **1** must be changed.

According to the various embodiments of the present invention, the second cutting blade **22** may be axially adjusted with respect to the second rotatable shaft **20**, individually and independently to other cutting blades disposed along the same or an opposing rotatable shaft, and without effect on or interaction with other adjustable or non-adjustable cutting blades disposed along the second rotatable shaft **20**, wherein such

a principle may also be extended to instances involving adjustable cutting blades on more than one shaft.

While the profile of each of the cutting blades **12,22** depicted in **Figs. 1-3** is substantially circular, the cutting blades **12, 22** may have a variety of profiles as will be appreciated by one skilled in the art. Such blade profiles may include, for example, generally circular shapes having angled "saw teeth", multi-sided polygons, and other shapes suitable for producing the necessary cutting action of sheet material. In addition, the configuration of the lateral cross-section of the blades **12,22** may vary from the unilateral taper configuration shown in **Fig. 1**, and may include other configurations suitable for providing the necessary cutting performance without departing from the spirit of the invention.

Many modifications and other embodiments of the invention will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing description. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.